

NAVAL HEALTH RESEARCH CENTER

REVIEW OF THE NAVAL HEALTH RESEARCH CENTER'S DEVELOPMENT OF MEDICAL INFORMATION SYSTEMS FOR FAR-FORWARD ECHELONS OF CARE: 1983-1997

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Review of the Naval Health Research Center's
Development of Medical Information Systems for Far-Forward Echelons of Care:
1983-1997

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Summary

Background

Far-forward echelons of care employ manual paper and pencil methods of recording and transferring medical information that is gathered in the field. These methods were found deficient in medical information documentation, patient tracking, and facility status reporting. The US military organized initiatives in automation to improve upon the inadequacies of the labor-intensive processes currently in place. The Naval Health Research Center (NHRC) created a range of prototypes designed to raise the standard of care at Echelons I and II.

Objective

The goal of this paper is to present an overview of the work completed from 1983-1997 by NHRC researchers in the development of medical information systems for far-forward echelons of care.

Discussion

Comprehensive descriptions of the Combat Casualty Care Medical Information System, the Revised Field Medical Card, the Medical Data Tag (MEDTAG), the Multi-technology Automated Reader Card, the Medical Tablet (MEDTAB), and MEDTRAK are given.

Conclusion

Although NHRC has developed successful prototypes of automation for the First and Second Echelons of care, these methods have yet to be instituted in the field. Because electronic devices like MEDTAG and MEDTAB must employ a specific technology, the systems cannot be configured and put into operation until a decision is made regarding what strategy will be used to compile individual medical records.

Abstract

It is imperative that medical treatment information be gathered quickly and accurately to ensure continuity of care at far-forward echelons. Each echelon employs a manual method of recording the medical information required for that particular level of care. The methods in use prior to and during the Vietnam War revealed the need for considerable improvements in medical information documentation, patient registration, patient tracking, facility status reporting, and effective transference of data throughout each of the first three echelons of care. The US military targeted these inadequacies for development; automation was determined as the direction in which documentation techniques could most significantly be enhanced. The Naval Health Research Center (NHRC) has been an integral part of the development of automation for the far-forward echelons of care. The prototypes designed by NHRC for Echelons I and II can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. An overview of NHRC's work in automation from 1983 to 1997 is presented.

Introduction

The Naval Health Research Center (NHRC) has been an integral part of the development of the automated collection of medical data for the far-forward echelons of care. Due to inadequate pen and paper documentation techniques, medical treatment is not rendered as quickly and effectively as NHRC demonstrates is possible. Figure 1 is a reference tool that shows the baseline capability of the field medical card (FMC) and the progression of new instruments designed by NHRC for Echelons I and II. These prototypes can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. Each operational system is designed to carry as much or as little information as necessary for its function. This flexibility allows the systems to be mission-specific by adapting to a range of scenarios, such as operations other than war, domestic emergencies, peacekeeping operations, and major theater wars.¹ An overview of NHRC's work in automation from 1983 to 1997 is presented.

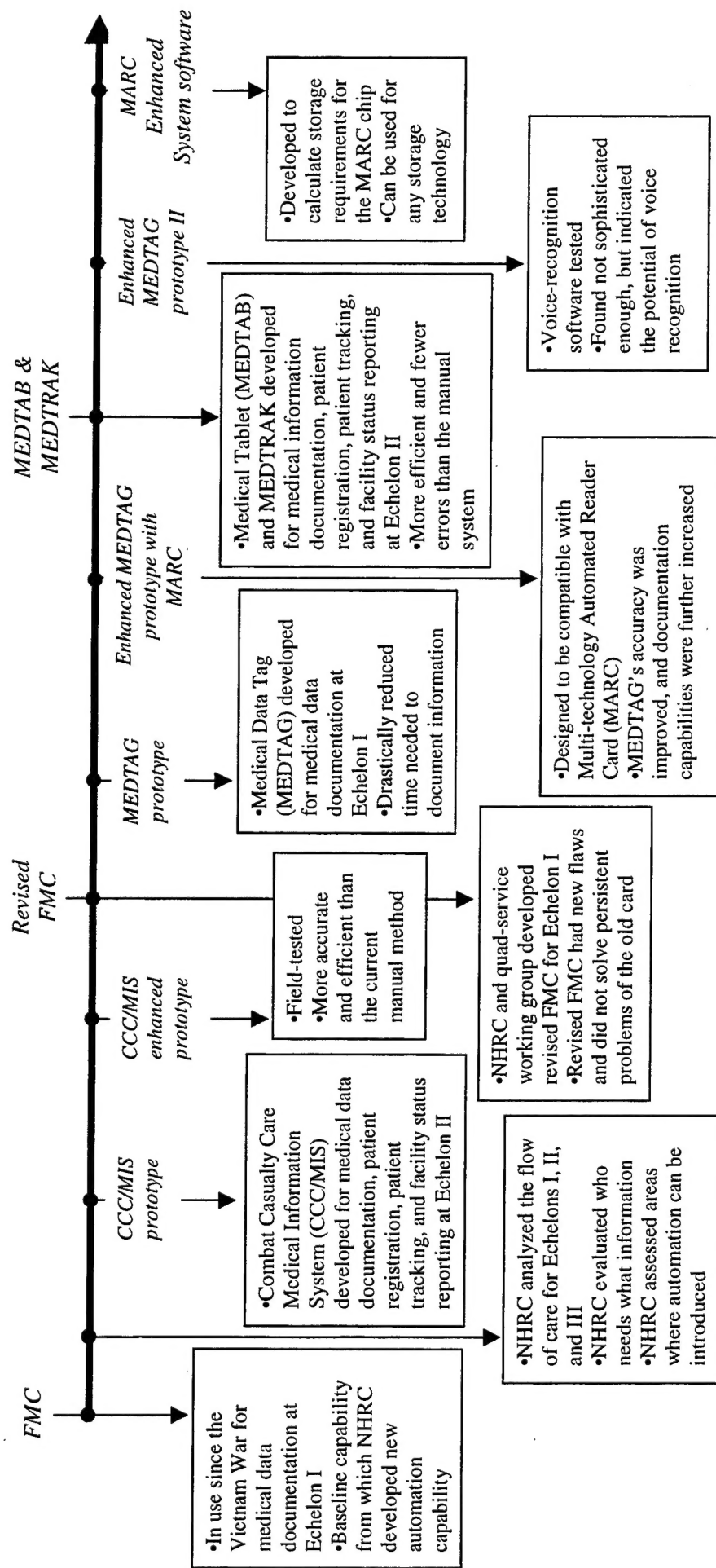
Background

Following military operations in Vietnam, several meetings were initiated to address the considerable problems with the maintenance of accurate and complete medical documentation. Loss of records, fractional or missing medical data, and incomplete communication of medical information throughout the evacuation chain negatively affected the medical treatment of casualties in Vietnam. The Technical Workshop on Combat Casualty Care, hosted in April 1976 by the Naval Medical Research and Development Command (NMRDC), as well as the Fleet Marine Force (FMF) Medical Information Systems Requirements Definition Workshop, sponsored by Headquarters, US Marine Corps and NMRDC in May 1982, identified the following deficiencies in documentation methods:²

- Medical data were frequently lost or not recorded.
- Communication of casualty information between echelons was inadequate.
- Reporting of casualty information was inaccurate or incomplete.
- Inadequate personnel tracking and accounting were widespread.
- Material inventory and replenishment methods were cumbersome and incomplete.
- Management reports were delayed and often inaccurate.
- The manual system (described below) was too lengthy and involved to record medical data accurately and completely in the time and scale required.

Many of these problems stem from the use of the FMC, Department of Defense form 1380 (Figure 2), which is the only record used to acquire patient injury and treatment data for casualties at the first level of care. As the initial source of medical treatment information, the Company Corpsman tags casualties with an FMC, ideally completed with identification data, treatment information such as type of injury, and time and type of medication given.² The cardboard-like card is bundled in booklets of 20 and consists of an original, which is attached with a wire to the casualty during transport, and a carbon copy that is retained by the medical provider. The FMC is attached to the casualty until the patient reaches a hospital setting where a formal inpatient record is generated. The FMC is then typically fastened to or wedged in the formal file.³

Figure 1. Progression of Automation Designed by NHRC from 1983-1997



Although the FMC should be attached to every casualty at the First Echelon of care, it is often omitted due to time constraints, battle conditions, and the physical needs of the patients.^{2,4} This disregard of the FMC has been tolerated on the premise that providing the best medical care to casualties takes priority over performing administrative functions. In addition, the card is sometimes torn off of the patient, or field conditions, such as rain and mud, damage the card,

Figure 2. Field Medical Card, DD Form 1380

1. NAME (Last-First-Middle Initial)/NOM, PRENOMS		2. SERVICE NUMBER/NUMERO MATRICULE	3. GRADE/GRADE	4. NATION/NATION (e.g. Etats Unis)
5. FORCE/ARMEE	6. BRANCH AND TRADE/ARME (e.g. Infanterie)		7. UNIT/UNITE	
8. AGE/AGE	10. RACE/RACE	11. RELIGION/RELIGION	12. FACILITY WHERE TAGGED/LIEU D'ETABLISSEMENT DE LA FICHE	
13. DATE AND HOUR TAGGED/DATE ET HEURE D'ETABLISSEMENT DE LA FICHE		14. DIAGNOSIS (including cause)/DIAGNOSTIC (Cause comprise)		
15. LINE OF DUTY/EN RELATION AVEC LE SERVICE		16. DATE & HOUR INJURED/DATE ET HEURE DE LA BLESSURE		
17. TREATMENT GIVEN (For antibiotics specify which and give dose, how and date)/ TRAITEMENT EFFECTUE (Si des antibiotiques ont été donnés, précisez leur nature, la dose, l'heure et la date)		18. WHAT WAS HE DOING WHEN INJURED/QUE FAISAIT-IL LORSQU'IL FUT BLESSE		
19. TOURNIQUET (Yes or No: Time & date applied)/ MISE EN PLACE D'UN GARNOT (Oui ou Non: heure et date)		20. MEDICAL OFFICER (Signature & Grade)/SIGNATURE ET GRADE DU MEDECIN		
21. DISPOSITION-DISPOSAL/DESTINATION DONNEE AU BLESSE		22. HOUR AND DATE/ HEURE ET DATE		
23. MORPHINE- 1st/MORPHINE- 1ere		24. MORPHINE- 2nd/MORPHINE- 2eme		
25. MORPHINE- 3rd /MORPHINE- 3eme		26. TETANUS TOXOID/ VACCIN ANTITETANIQUE		
27. A. T. SERUM/SERUM ANTITETANIQUE		28. MEDICAL OFFICER (Signature & Grade)/SIGNATURE ET GRADE DU MEDECIN		

DD FORM 1380, 1 JUN 62
S/N 0102-LF-013-5500

U. S. FIELD MEDICAL CARD/FICHE MEDICALE DE L'AVANT ETATS-UNIS

a. ABSOLUTION/CONFESSION		b. HOLY COMMUNION/SAINTE COMMUNION		c. EXTREME UNCTION/EXTREME ONCTION	
30. d. OTHER MINISTRATIONS/AUTRES MINISTERES		e. CHAPLAIN (Signature)/SIGNATURE DE L'AUMONIER			
31. DIET/REGIME ALIMENTAIRE					
<input type="checkbox"/> REGULAR/NORMAL <input type="checkbox"/> LIQUID/LIQUIDE <input type="checkbox"/> NOTHING BY MOUTH/RIEN PAR VOIE ORALE					
32. REMARKS/REMARQUES					

making it illegible. If the writing instrument required for the FMC is lost in battle, its absence results in the card not being filled out.^{5,6}

Due to such daunting problems in maintaining accurate and complete medical data, participants of the post-Vietnam conferences concluded that automated information systems be studied and implemented at each level of the evacuation chain. To assess how and where automation should be introduced, participants in the workshops defined data requirements for Echelons I, II, and III. They agreed that the data collected should be confined to the minimal information necessary for the treatment of the casualty at the next echelon of care.² The information collected at Echelon I would identify the casualty and establish a casualty care record that includes site and type of wound, time of injury, and type of medication administered. Echelon II requirements were to include more-detailed descriptions of the injury and the medications. At Echelon III, documentation of treatment and medication should be continued and the patient's diagnosis and disposition should be made.³ More detailed descriptions of the data requirements for each echelon of care are provided in Pugh et al.³ and Bollinger et al.⁷

With the requirements defined, NHRC then hosted the Fleet Marine Force Combat Casualty Care Information System Conference in 1984 to apply the results of the 1982 FMF Medical Information Systems Requirements Definition workshop to the design of the Combat Casualty Care Medical Information System (CCC/MIS).⁴ The meeting initiated the design of the Navy's first automated system, a CCC/MIS prototype for the surgical company (SC) at the Second Echelon of care. Laying the groundwork, NHRC researchers investigated various methods of available technology to assess which would be appropriate for Echelon II.^{3,7} This was followed by an exhaustive analysis of the flow of care in order to see how automation could best be incorporated.²

Discussion

Flow of Care

The Marine Corps continues to array its medical treatment facilities in a series of echelons to provide care for patients being evacuated and treated far forward. Each higher echelon is characterized by increased medical capability and decreased mobility. The evacuation chain is the process by which casualties are taken through these levels until they arrive at a facility that has the capacity for proper treatment of sustained injuries. The following is a summary of the responsibilities of the first two echelons and how information is transferred between them.²

Predeployment. Two identification tags are issued to individuals before entering combat. Worn at all times, the tags contain name, service number, blood type, service component, religion, and gas mask size. These tags remain with the casualties as they are sent through the evacuation chain so that medical staff have access to basic identification information.

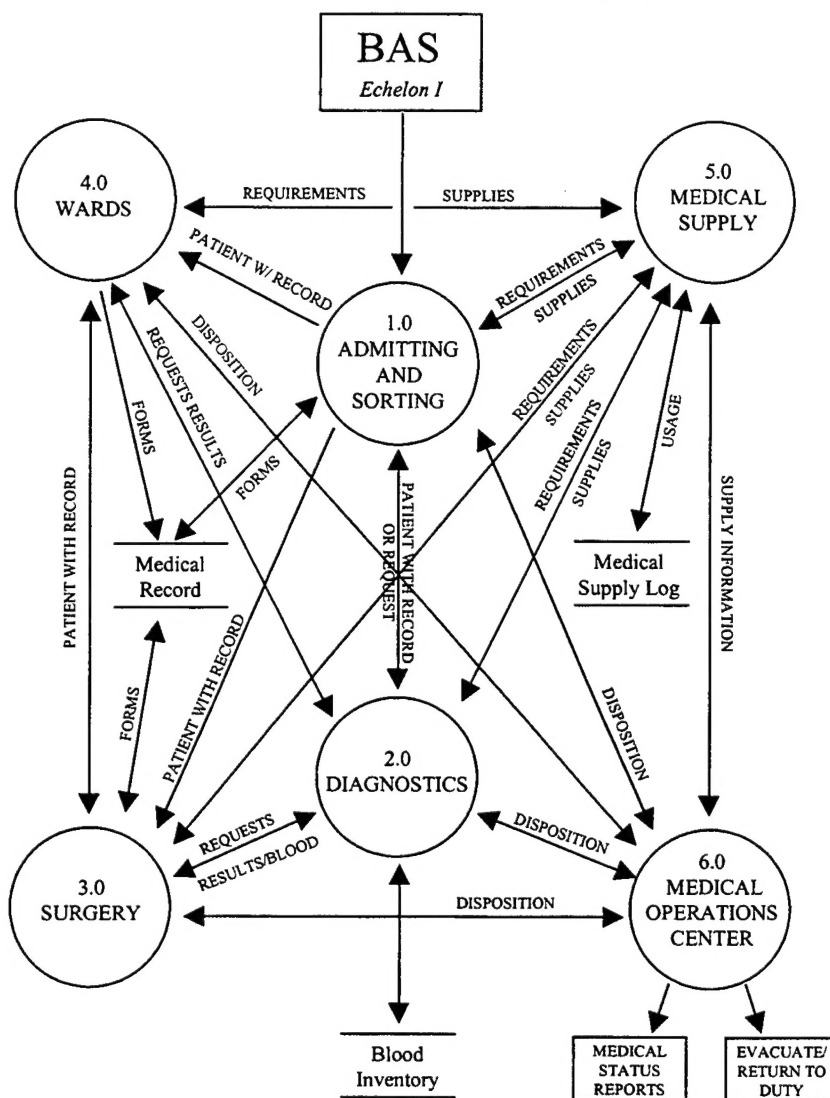
Echelon I. If an individual is wounded, the Company Corpsman is the first to administer treatment. After giving first aid, the corpsman tags the casualty with the FMC, ideally completed with identification and treatment data. Throughout evacuation, the original card remains attached to the patient until the battalion aid station (BAS) is reached.

The BAS offers clinical assessment. The treatment administered here includes the use of intravenous fluids, antibiotics, preservation of the airway by surgical procedure, and application of more-secure splints and/or bandages. Treatment given at the BAS is recorded on the FMC; if the individual cannot return to duty, the card is sent with the casualty through the evacuation process.

Echelon II. The surgical company at Echelon II has operating room capability, a basic laboratory, pharmacy equipment and supplies, whole blood capability, and holding wards. Figure 3 shows the complexity of the information flows of the manual system currently in use. The casualty enters in Admitting and Sorting, receives emergency resuscitative care, and is checked for ordnance. Weapons, gear, and clothing are tagged with the information from the identification tags or the FMC. Moved to the Triage area, the individual is grouped by the

Triage Officer into a category according to the severity of wounds. In the Casualty Receiving area, blood is drawn for laboratory tests, and x-rays are ordered; these requests are sent to Diagnostics. The patient's condition is more thoroughly assessed, and the casualty receives a priority for surgery. A clinical file that includes all the necessary forms for the surgical company is started for the patient; the FMC is removed and placed into the folder. The Medical Operations Center (MOC), the area responsible for the administrative aspects of patient care, is also notified of the casualty's admission. From this point forward, any change in the patient's location or status is reported to MOC for tracking purposes. A hand-kept paper record is made noting time, date, name, and status. The casualty is then sent to Surgery, which includes the Preoperative area, the Operating Room (OR), and the Intensive Care/Recovery area. Subsequently, the patient reaches the Wards. In addition, a Medical Supply representative evaluates the supply levels at each functional area; the representative lists the supply needs on a requisition form, then delivers the materiel to the appropriate area. With information provided by the other areas of the SC, the MOC maintains status boards that present medical staff with valuable information, such as

Figure 3. Information Flows in the Surgical Company



patient flow, bed status, operating room backlog, blood status, and personnel status (for a thorough account of the flow of care, see Congleton et al.²).

During field research, it was discovered that MOC sometimes inaccurately recorded the numbers and types of casualties, even in low casualty situations. The status reports intended for higher echelons of care were problematic because they were not sufficiently accurate. Patient tracking was also inaccurate, resulting in misuse of personnel and lowering of the standard of care.² In addition, redundant and/or nonessential data collection caused personnel to expend more time and effort than necessary. In fact, due to the demand of administrative duties, the equivalent of 3.5 medical personnel were unavailable to provide care to casualties.⁴ NHRC proposed the CCC/MIS prototype to resolve these issues by making patient tracking and administrative duties at the SC more efficient and accurate.

Combat Casualty Care Medical Information System (CCC/MIS)

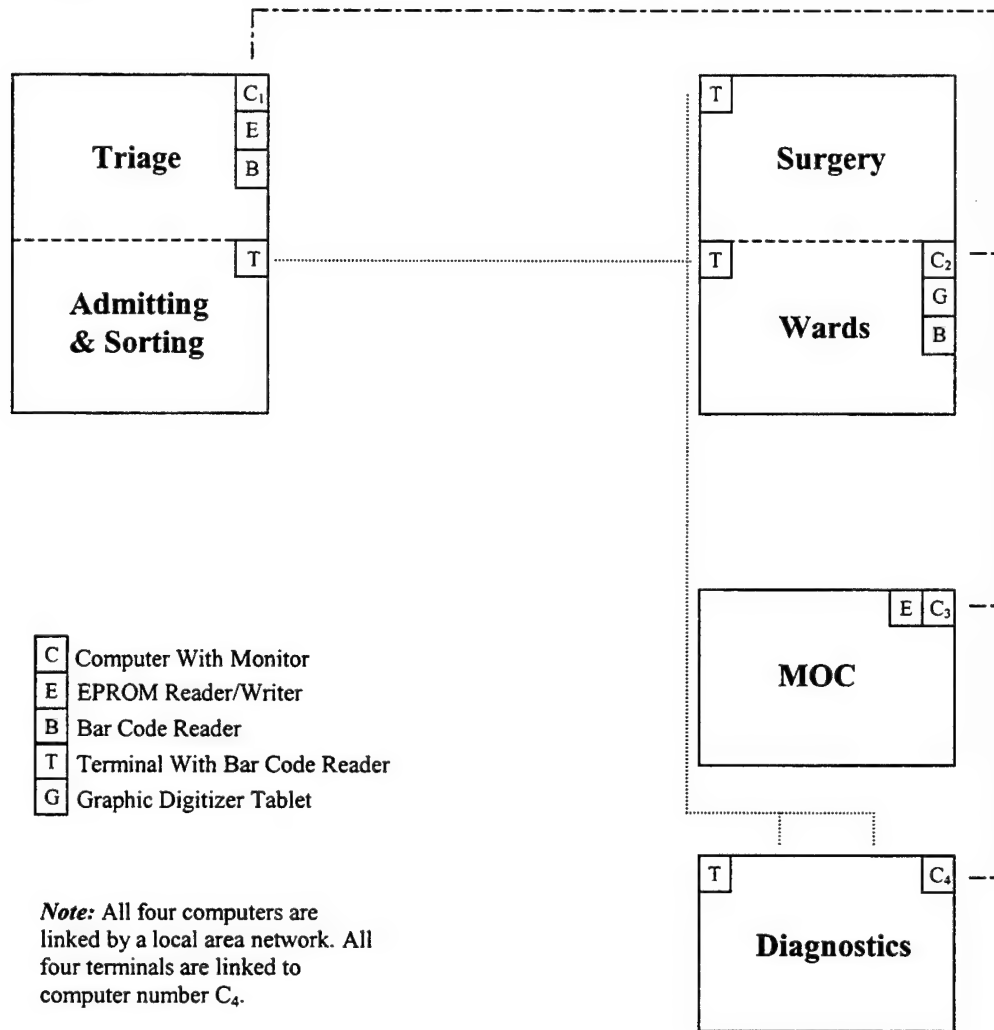
The objectives of the first CCC/MIS prototype for Echelon II are to perform patient registration; time, date, and location logging; medical information input and storage; generation of spot status reports; and patient discharge.^{4,8} The system consists of four IBM-compatible microcomputers, two electronic programmable read-only memory (EPROM) reader/writers with individual EPROM data carriers, one graphics digitizer tablet, and four small, two-line bar code terminals placed throughout the SC. Figure 4 is a diagram of the system's configuration.

Patient registration and discharge are accomplished by assigning individual data carriers to each casualty. This device is similar in size to a dog tag and used to store personal and medical information electronically. For registration, the data carrier is placed into a reader; its information is merged with a computer-generated identification (ID) number and the date and time of registration, as well as any additional triage data the provider includes. For discharge, the same process is required. However, at each entry point, the staff person has the choice of using keyboard entry, bar code pen, or the data carrier as appropriate, making the documentation process quicker and more efficient.

CCC/MIS also includes a version of the FMC printed on indestructible Mylar and used with a graphics digitizer tablet. When contact is made at a particular point with a stylus, this tablet is programmed to translate the grid coordinates into specific data. One benefit of this simple documentation procedure is the opportunity to use nonmedical personnel to operate it.

An automatic logging function is also incorporated into the system. Each patient is required to wear a wristband with a bar code unique to that person; an additional bar code response pad is placed at each functional area. When the patient travels from one area to another, a staff person uses the bar code equipment to read the wristband, logging the patient's personal identification information with computer-generated time, date, and location into the system. With these data, the system can generate patient status reports every 5 minutes. This feature updates staff with valuable information, such as lists of casualties currently in treatment, discharged patients, patient locations, and bed types available and in use.

Figure 4. CCC/MIS Hardware Location and Configuration



Although the CCC/MIS prototype certainly verified the potential for improvement in the documentation process at the Second Echelon of care, the demonstration highlighted areas that needed to be improved. The bar code terminals were problematic, requiring excessive programming for integration with the system. The IBM-compatible computers of the time also failed frequently, and manufacturers did not offer adequate technical support.

CCC/MIS-Enhanced Prototype

Retaining the successful structure of CCC/MIS, researchers incorporated more-suitable technology in the model before testing it in the field.⁹ Four IBMs, each complete with peripheral equipment for entering and retrieving data, were substituted for the initial ruggedized computers that often failed. The new system also replaced the problematic bar code equipment with a radio frequency tag system. Because each patient is given an radio frequency tag that can be automatically tracked throughout the SC, no staff person is required for the tracking process. Furthermore, it was concluded that an additional monitor be placed in the OR to provide the medical staff with information, such as types of injuries incurred, preliminary and postoperative patient status, and treatment given.

The field test showed CCC/MIS to be more efficient and accurate than the first prototype and far superior to the current manual method of tracking medical information. Field-testing demonstrated that CCC/MIS was able to locate any patient at any time, to evaluate and report on resource allocation, to maintain an accurate medical file on each casualty, and to discharge patients with an attached electronic copy of their treatment. However, the most necessary improvement lay in the system's ability to endure weather and abuse, such as dust, wind, and rain, being dropped, kicked, shifted, and other various battle conditions. Nevertheless, the potential of the CCC/MIS is quite remarkable; implementation of this system at Echelon II would free 4 to 6 medical personnel from administrative duties, maximizing the standard of care.

Revised Field Medical Card

During the studies on automation, NHRC represented the Navy on a quad-service working group assembled to develop and test a revised FMC (Figure 5) in response to the Medical Readiness Strategic Plan 1988. The following is a summary of the proposed changes:⁵

- A graphic display depicts the front and back of a human figure next to a checklist of common battlefield injuries.
- The back side of the new card is specifically designed for the BAS.
- A special tear-resistant material is used to improve data survivability.
- Two holes are placed at the top of the card to permit standard alignment in a medical folder.
- The new card adopts a format of boxes for checking off treatment and medication times.
- For administrative purposes, the new card employs a partial copy on carbonless paper.
- A vertical display is used for proper alignment in a medical folder and ease of use.
- The new cards are bundled in packs of 10, as opposed to 20 in the older version.

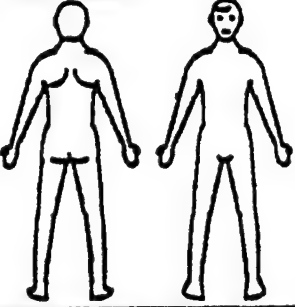
Field-testing was conducted in a variety of settings under myriad conditions to evaluate the revised FMC. The cards were judged on four criteria: durability, sufficiency, ease of use, and simplicity.

Although the revised FMC was an improvement in some areas, new flaws developed in addition to the many persistent problems of the old card. Below is a brief synopsis of the evaluation (for a detailed description of this study, refer to Wilcox et al.⁵):

Durability: The new material was extremely rugged and tear-resistant; however, there was no significant improvement in legibility over the old card when both cards were cleaned of foreign substances. Oil, mouse blood, and povidone iodine showed no effect on either card. Saline and soapy water defaced the old card, while soapy water, alcohol, and mud damaged the new card. In addition, the new card failed when used under simulated adverse weather conditions. The revised FMC was doused in running water to simulate a rainstorm; efforts to write on the card produced an illegible document. When exposed to flame, the new card immediately began to melt and emit noxious fumes.

Sufficiency: Although appropriate spaces were provided on the new card to obtain patient identification along with injury and treatment data, the new card was less effective in obtaining the information. Forty-four percent of the cards filled out in the study had partial or missing identification data, date, or time. The new administrative stub was also less effective at documenting information than the copy used in the old form. The new administrative stub had additional problems with legibility and potential loss. Only 47% of the stubs in the study had a legible date, 50% a legible time, and 57% had adequate ID information.

Figure 5. Revised Field Medical Card

1. DATE / TIME INJURED / DATE / HEURE DE LA BLESSURE			
2. INJURY / BLESSURE		WOUND / BLESSURE PUNCTURE / PERFORATION FRACTURE / FRACTURE BURN / BRULURE AMPUTATION / AMPUTATION NECK / BACK INJURY / BLESSURE AU CŒUR AU DOS CONCUSSION / COMOTION CÉRÉBRALE STRESS / STRESS NBS / NBS OTHER / AUTRES / AUTRES	
			
3. TOURNIQUET / TOURNIQUET		DATE / DATE	TIME / HEURE
YES / OUI		NO / NON	
4. PULSE / PULS	(1)	TIME / HEURE	(2)
5. LEVEL OF CONSCIOUSNESS / NIVEAU DE CONSCIENCE		TIME / HEURE	
ALERT / ALERTE		UNCONSCIOUS / INCONSCIENT	
CONSCIOUS / CONSCIENT		PAIN RESPONSE / REPONSE A LA DOLLEUR	
VITAL RESPONSE / REPONSE VITALE		UNRESPONSIVE / SANS REPONSE	
6. MORPHINE / MORPHINE	DOSE / DOSE	TIME / HEURE	DATE / DATE
7. ATROPINE INJECTIONS / INJECTIONS D'ATROPINE			
TIME GIVEN / DONNE A HEURE	(1)	(2)	(3)
8. 2-PAM CHLORIDE / 2-PAM CHLORIDE			
(1)	(2)	(3)	(4)
9. COMMENTS / OBSERVATIONS / TREATMENT / CURRENT MEDICATION / ALLERGIES / COMMENTAIRES / OBSERVATIONS / TRAITEMENT / PRESENTE MEDICATION / ALLERGIES			
10. PROVIDER / UNIT / OFFICER MEDICAL / UNITE			
11. DISPOSITION / DISPOSITION		RETURNED TO DUTY / RETOUR A L'UNITE	
DATE / DATE		EVACUATED / EVACUE	
TIME / HEURE		EXPIRED / DECEDÉ	
12. IDENTIFICATION			
NAME / NOM		MALE / HOMME	
		FEMALE / FEMME	
SSN / NBS	RANK / RANG	RELIGION / RELIGION	
FORCE / ELEMENT	SPECIALTY CODE / OPM	B / BC	
A / T	G / A	NBS / BNC	
NATION / PAYS	UNIT / UNITE	ILLNESS / MALADIE	
		PSYCH / PSYCH	

DD Form 1380 TEST, MAY 89

U.S. FIELD MEDICAL CARD

FIGE MEDICALE DE L'AVANT ETATS-UNIS

14. REASSESSMENT / REASSESSMENT			
DATE / DATE		TIME OF ARRIVAL / HEURE D'ARRIVEE	
Time / Heure		Comments / Commentaires	
SP / PS			
PULSE / PULS			
RESP / RESP			
CHB / SN			
IV / IV			
15. TETANUS / TETANUS	DOSE / DOSE	TIME / HEURE	DATE / DATE
16. ANTIBIOTICS (Supply) / ANTIBIOTIQUES (Supply)			
DOSE / DOSE	TIME / HEURE	DATE / DATE	
17. CLINICAL COMMENTS / DIAGNOSIS / INFORMATION MEDICALE / DIAGNOSTIQUES			
18. OTHER / DIVERS / DIVERS			
19. PROVIDER / OFFICER MEDICAL			
20. DISPOSITION / DISPOSITION		RETURNED TO DUTY / RETOUR A L'UNITE	
DATE / DATE		EVACUATED / EVACUE	
TIME / HEURE		EXPIRED / DECEDÉ	
21. RELIGIOUS SERVICES			
BAPTISM / BAPTISE	CONFESSION / CONFESION		
ANONING / ONCTION	PRAYER / PRIERE		
CHAPLAIN / PRETRE:			

DD Form 1380 TEST Reverse, MAY 89

Ease of Use: The new card was rated as easier to use because the checklists and graphic displays were easier to mark, and the vertical orientation was more appropriate. However, many items on the card, such as time and date, were overlooked or left blank. In general, response rates were low; those for pulse rate, administration of atropine, 2-PAM chloride, and intravenous fluids were only 28%, 33%, 13%, and 33%, respectively. Response rates for level of consciousness, use of tourniquet, and administration of morphine were 65%, 63%, and 50%, respectively. In addition, some type of writing instrument was still required.

Simplicity: The time required to fill out the form under ideal conditions was reduced, but the time required under simulated battle conditions was still unacceptable. The new card can be more quickly read and understood; however, 55% of study participants stated that there were abbreviations/acronyms on the new card that they didn't understand, creating interpretation problems. Furthermore, even with extensive training and close supervision, many trainees could not fill out the cards correctly. Only 21% of cards were missing important injury data, but 67% were missing critical treatment data. In addition, the problems related to filling out the card while attired in Arctic and Mission Oriented Protective Posture suits still exist.

Furthermore, because only medical personnel possessed the booklets containing the FMC, any buddy or self-administered treatment could not be documented.

The revised FMC did not fare as well as researchers had hoped. With the revised FMC falling short, efforts in automation were further concentrated; the prototype of the Medical Data Tag, known as MEDTAG, was created.

Medical Data Tag (MEDTAG)

First stage. In the 1980s, the Army designed the Theater Army Medical Management Information System (TAMMIS), which electronically acquired medical and administrative information at the Third Echelon. TAMMIS was then manipulated to operate at the Second Echelon medical facilities; the Individual Carried Record (ICR) was conceptualized as part of TAMMIS to implement medical record-keeping requirements for Echelon II. Although this initiative was unsuccessful, NHRC expanded the ICR model into MEDTAG for use at the First Echelon of care.¹⁰

NHRC designed the MEDTAG model to capture data through the interaction of a handheld device and personal data carrier (similar to the ICR) worn by individual personnel (Figure

Figure 6. MEDTAG Prototype With Personal Data Carrier



6). The functional prototype of MEDTAG includes EPROM, electronic erasable programmable read-only memory, an integrated read/write capability, and an internal clock to provide accurate date and time-tracking. Other features are a backlit screen to present the user with menu options, two mechanical data input buttons to select information; an activation switch, a data communications port to transfer information to and from a host computer, core electronics, and an external power pack.

Personal identification data comparable to those required by the FMC card are preloaded into MEDTAG from a personal computer (PC). The two-button configuration allows the user to rapidly store and retrieve data by negotiating menus related to injury assessment, treatment, patient condition, and patient disposition. Appendix A contains a complete list of these menus. This information could then be transferred to a PC for printed or electronic storage.¹⁰

The results and recommendations of the evaluation of MEDTAG are summarized below (for a description of this study, refer to Galarneau et al.¹⁰):

- The two-button data entry methodology facilitated rapid data input.
- The multimenu, multilevel data entry methodology was easily learned.
- The number of data elements in each of the MAIN MENU categories should be expanded to include a wider range of items.
- Prompts should be added which inform users when a selected item is permanently recorded.
- The SHOW DATA function for reviewing previously recorded data should use a screen scrolling feature, that automatically displays one line of data at a time.
- The END menu option should be replaced with another term that more clearly communicates its function, such as EXIT.
- The on/off toggle switch used to activate the prototype should be replaced by a mechanism that more closely indicates the irreversibility of the activation function.
- Display backlighting intensity should be adjustable.
- Protective covers or seals should be used to reduce the potential for environmental exposure of internal electronic components.

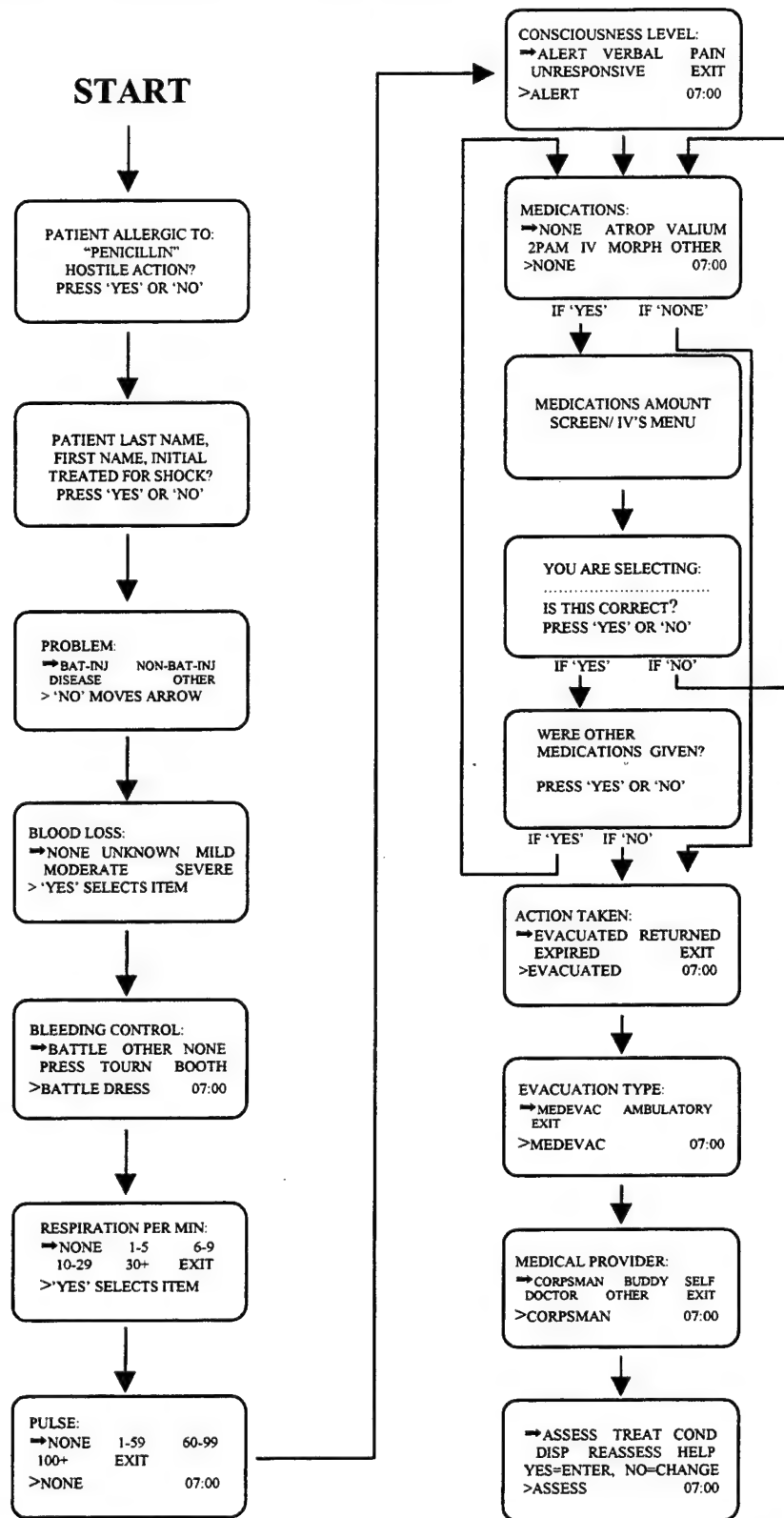
This MEDTAG device was able to store and review relevant personal and medical data rapidly and accurately via a hand-held instrument that did not rely on supporting equipment. The MEDTAG prototype was continually improved and tested to maximize its potential. Its concept was also the framework for automation in the Second Echelon of care.

Second stage-enhanced MEDTAG prototype. The Office of the Secretary of Defense requested that MEDTAG be designed to interface with the Multi-technology Automated Reader Card (MARC), an electronic information carrier used to hold a variety of records, including personnel, disbursing, and food service data. Proposed in 1984 by the Department of Defense Information Technology Policy Board,¹¹ MARC is a personal electronic data carrier worn like a dog tag by each Corpsman. Known at the time also as a smart card or Portable Information Carrier, MARC incorporates five data storage media: printed, embossed, and bar code, which are static; and magnetic strip and an integrated circuit chip, which can be modified. As a portable medical profile, MARC stores a medical record and a demographic file. It includes information such as name, social security number, blood type, and can store treatment, patient condition, and medication administration data. The project of integrating a medical function into the card was undertaken by the 25th Infantry Division on Oahu, Hawaii; the study concluded that MEDTAG integrated with MARC is capable of greatly improving battlefield medical data documentation.¹²

Several additional improvements were incorporated into the enhanced MEDTAG model (patent number 5,995,077 issued November, 1999 by the United States Patent Office¹³). For a detailed description of this prototype, see Galarneau et al.¹⁴

- New design.
- Hardware is resistant to shock and environmental contamination.
- Incorporation of a potentiometer to adjust the lighting of the screen.
- Internal power supply.

Figure 7. MEDTAG's Activation Sequence



activation due to the preloaded information on MARC. A significant advantage of the MEDTAG was that the user need only focus energy on recording medical data rather than entering the

- One-way slide switch to indicate irreversible nature of activation.
- Status check software to display system info (ID, time, date) including a low battery warning.
- Date and time are recorded automatically at activation.
- Glasgow Coma Scale and the Revised Trauma Score are calculated with an automatic screen scrolling feature.
- 62 possible injuries/illnesses, 71 anatomical locations, 48 treatments, 14 patient conditions are available for documentation.¹⁵
- "Help" section included to provide lifesaving information and list documented items.¹⁵

Two different programs were designed for MEDTAG.¹⁴ The first program, "Prompted" data input, combines user-directed documentation and an automatic prompting activation sequence where the user navigates preselected items limited to information common to battlefield encounters. These items account for the majority of the data requirements of the FMC. Instead of each item being selected by the user, the Prompted data input mode is initiated upon activation (Figure 7). When the menus are completed, the program automatically enters the "Extended" mode to finish the task. The second program consists solely of the Extended mode, the user-directed documentation method by which each item is selected by the user.

Both versions of the MEDTAG software registered impressive results. The Extended (user-directed) mode demonstrated that 38% of the data required by the FMC is available to the user upon

patient ID information, date, and time that were already recorded on the MARC. MEDTAG also produced considerably more accurate and complete documentation in the areas of patient condition, patient disposition, and treatment. The amount of time to record data was also significantly reduced across all conditions. However, MEDTAG was less successful than the FMC in detailing injury information. This was most evident in documenting sucking chest wounds; the FMC had a 94% accuracy and completeness rate in comparison with MEDTAG's 74%.

The second study tested the combination of the Extended mode and the Prompted data input mode. This method was 17% faster in recording the required information than the Extended mode alone and 30% faster when measured against the FMC. Search time was drastically reduced because the device presented the user with menus that contained information that should be recorded in all, or most, casualty encounters. More importantly, significant improvements were made in injury documentation, ranging from 19% to 30%, when compared with the Extended mode alone in the first study. When compared with the FMC, where the Extended mode alone was deficient, the Extended with Prompting mode demonstrated no significant differences in documenting injury information. Furthermore, perfect documentation was achieved in the areas of patient condition and patient disposition. These improvements in accuracy and completeness were attributed to the program's automatic presentation of items that otherwise may have been forgotten or ignored. Therefore, accuracy and completeness increased without compromising the quality of care given to the casualty.

To ensure that battlefield information requirements would be sufficiently fulfilled, an exhaustive study to review MEDTAG's menu options was undertaken. Each menu item in MEDTAG was placed into a master database to which the relevant medical items NHRC collected would be compared (refer to Wilcox et al.¹⁵).

Of the items considered appropriate for documentation at the First Echelon of care, 93% were successfully recorded by MEDTAG. Items that could not be sufficiently recorded fell almost entirely into the patient conditions group, demonstrating the need for MEDTAG's capability to be expanded in this area.

Third stage—enhanced prototype II. Most recently, the MEDTAG concept was evaluated using speech recognition. This new technology offers a great deal of potential; corpsmen would significantly benefit from a voice input program because their eyes and hands are busy when giving medical care to a casualty. Voice input would allow a provider to perform medical tasks while documenting them at the same time simply by speaking.¹⁶

The MEDTAG concept was tested in a laboratory study with keyboard, two-button, and voice methods of data entry; measurements in speed and accuracy were compared to determine which method would be most beneficial. The results indicated that the two-button and keyboard methods were significantly faster (8.4% and 4.7%, respectively) than the voice data entry method. This may have been due to the novelty of the voice input technology. The program was also new to the users, perhaps slowing them down and making them more cautious.

The voice input method made fewer errors in relation to inaccurate and/or missing data, as well as fewer hardware and software errors; however, voice input registered a significant

amount of errors that were method-specific, such as speaking with the microphone off and using a word the system did not recognize.

The preference of the user was also evaluated. Keyboard and voice input were viewed by the users as easy to learn and operate, while the keyboard and two-button methods were recognized as faster than the FMC. Also, corpsmen felt comfortable using the microphone and speaking to the computer. When asked which of the three methods would be most effective at Echelon I, the two-button method was favored the most. However, the participants stated that they would like the option of using a voice input system when delivering medical care.

This study identified troublesome areas in which future research would be most beneficial to the expansion of MEDTAG's capability. Problems not encountered in the laboratory study but found in the field, such as speaking style, noise, ambiguity of language, and confusion, would all affect voice input. Interface improvements are also necessary for voice input method feasibility. Vocabulary size and content, continuous speech, constraints on grammar and speaking style, and the way the system handles errors in speech understanding all need to be augmented. The study concluded that a combination of modalities would best suit the Echelon I medical provider.

Patient Tracking System—MEDTAB and MEDTRAK

The success demonstrated by MEDTAG at Echelon I led to the development of two automation systems designed for medical information documentation at Echelon II. SCs are responsible for establishing and maintaining treatment facilities for surgery, caring for casualties evacuated from the BAS, and providing short-term hospitalization. Building on the CCC/MIS and MEDTAG, Medical Tablet (MEDTAB) and MEDTRAK are two software programs that work collectively to document medical information, track patient location, and generate facility status reports critical to personnel and supply distribution.¹⁷

Figure 8. The Top-Level Screen: Overall View of Casualties Currently in the System

The screenshot displays the MEDTAB Echelon Two interface. At the top, it shows the date and time 'Thu Feb 27 1997, 16:052' and the program name 'MEDTAB Echelon Two'. Below this is a table of casualties with columns for No, SSN, Loc, and Name. To the right of the table is a 'Select' menu with various options, and at the bottom right are buttons for 'New Patient', 'Select Patient', 'Send Patient', 'Refresh Patient List', 'Comm ???', and 'Exit'.

No	SSN	Loc	Name
000	000-00-0000	Lab	LAB PATIENTS
006	123-45-6789	X_RAY	UNKNOWN,
007	123-45-6789	A_WARD	UNKNOWN,
008	123-45-6789	A_AND_S	UNKNOWN,
009	123-45-6789	DISCHARGE	UNKNOWN,
010	123-45-6789	Triage	UNKNOWN,
011	123-45-6789	Sick_Call	UNKNOWN,
012	123-45-6789	Triage	UNKNOWN,
013	123-45-6789	X_RAY	UNKNOWN,
014	123-45-6789	OR_1	UNKNOWN,
015	123-45-6789	PRE_OP	UNKNOWN,
016	123-45-6789	[PRE_OP]	UNKNOWN,
017	123-45-6789	OR_1	UNKNOWN,
018	123-45-6789	DISCHARGE	UNKNOWN,
019	123-45-6789	DISCHARGE	UNKNOWN,
020	123-45-6789	[G_WARD]	UNKNOWN,
021	123-45-6789	X_RAY	UNKNOWN,

Select

- LAB
- A_AND_S
- A_WARD
- DISCHARGE
- Dental
- G_WARD
- IN_TRANSI
- more-

Buttons:

- New Patient
- Select Patient
- Send Patient
- Refresh Patient List
- Comm ???
- Exit

Figure 9. Main Screen: View of MEDTAB Information for Patient #14

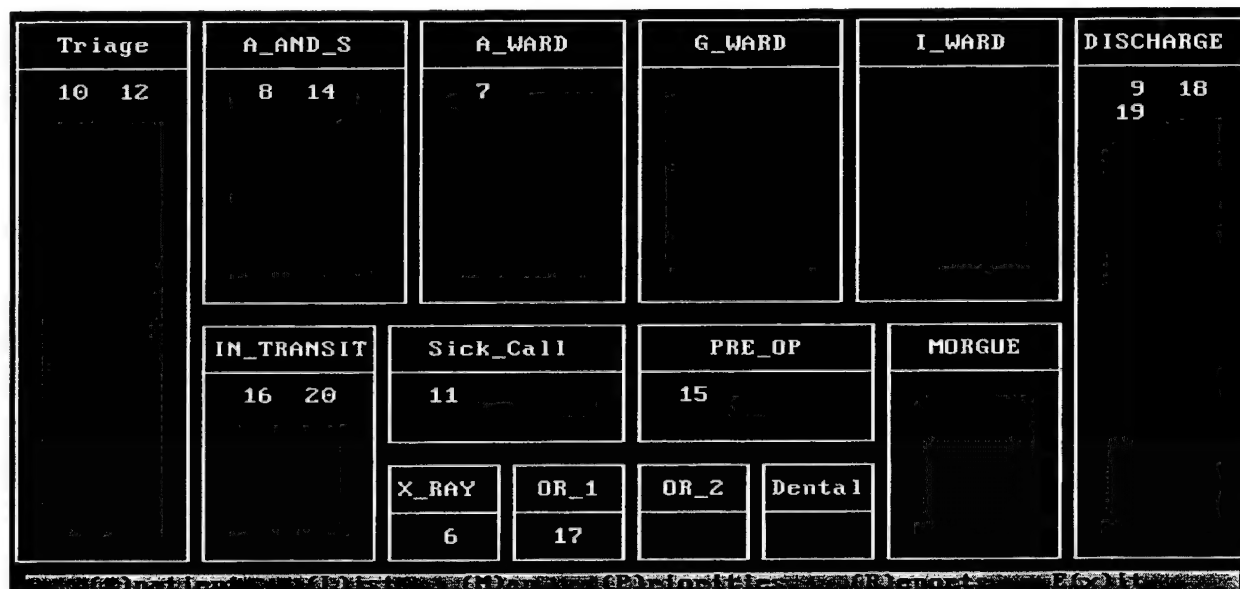
Thu Feb 27 1997, 16:061		O R - 1		Top Level	
Fri Jan 24 13:39	TRANSFER TO TRIAGE	MEDTAB Info	14 UNKNOWN		
Fri Jan 24 14:14	PRIORITY HIGH				
Fri Jan 24 14:14	PRIORITY FOR OR	Priorities	LAB		
Wed Feb 19 11:37	IN TRANSIT				
Wed Feb 19 11:37	TRANSFER TO A_AND_S	Next Location	MOC Send Poll		
Wed Feb 19 11:37	GUNSHOT WOUND				
Wed Feb 19 11:37	EXIT WOUND				
Wed Feb 19 11:37	BATTLE/FIELD DRESSING				
Wed Feb 19 11:37	RINGERS LACTATE				
Wed Feb 19 11:37	1500 cc				
Wed Feb 19 11:37	16 GAUGE NEEDLE				
Wed Feb 19 11:38	RESPONDS TO PAIN				
Wed Feb 19 11:38	MEDEVAC				
Wed Feb 19 11:39	IN TRANSIT				
Wed Feb 19 11:39	TRANSFER TO X_RAY				
Wed Feb 19 11:39	XRAY				
Wed Feb 19 11:39	LEFT SIDE	Xfer to DISCHARG	Next		
-more-					

The data collection method in place at Echelon II is not adequate for several reasons. First, the MOC, administrative headquarters of Echelon II, relies upon information manually supplied by personnel within each functional area of the facility. Medical data are recorded on forms and in log books, and tracking data are maintained through status boards, field phones, and runners. With these data, MOC monitors critical information, such as patient flow, bed availability, operating room backlog, and blood management. The current system requires a significant amount of qualified medical personnel to operate as administrators, thereby reducing the facility's ability to provide the highest level of care.^{11,17}

When a casualty is admitted at the medical treatment facility, the patient's MARC card is downloaded into the MEDTAB system where personal identification data and medical information are accessed. The casualty's record is transmitted automatically via radio frequency to MEDTRAK on the MOC central computer. MEDTAB software then admits the individual, generates a patient number, and creates a medical record in which all future information is stored until discharge. When the casualty is transferred from one area of care or received into a new location, the radio frequency of the hand-held PC notifies the central unit. MEDTRAK updates the casualty's location within the facility.

MEDTAB documents individual patient medical information. By navigating through various computer screens, the medical provider can successfully detail patient condition and treatment, request and review laboratory tests, and prioritize the order in which casualties are to be transported to Surgical Shock Trauma, X-Ray, and the OR. Figure 8 is the top-level screen, which displays an overall view of the casualties currently in the system. Figure 9, the main screen, displays the individual medical information documented on a specific patient.

Figure 10. Map of the Surgical Company



The MEDTRAK software on the central computer can access all patient records generated and transmitted by MEDTAB. MEDTRAK's goal is to track the casualties within the SC; a map of the functional areas displays patients by number in their respective location (Figure 10). MEDTRAK also has the option to list patients by name and social security number in order to locate an individual. The software has the ability to print critical reports, such as patient record, patient list, patient location, and supply/resupply inventory. Reports such as those accounting for bed status, blood status, and lab status were still being developed at the time the report was published.¹⁷

When MEDTAB and MEDTRAK were tested against the current paper-and-pencil method of recording information, the prototype performed significantly better than the manual system. General tracking errors occurred in both the manual and automated systems because neither is a real-time method. The tracking function was either slightly ahead or behind the actual movement of the patient; these errors had minimal effect because they were self-correcting. Both methods had approximately the same number of these errors. Inaccuracy errors, where the patient's location is unknown, are more serious because they effect the quality of care. The manual system had significantly more errors of this type. System failure errors occurred when patients traveled through recovery without their presence being reported. These errors affected not only the quality of care, but also medical regulating procedures and theater evacuation policy. MEDTAB and MEDTRAK did not commit any of these types of errors. In fact, overall, the manual method committed 62% more errors than the automated process.

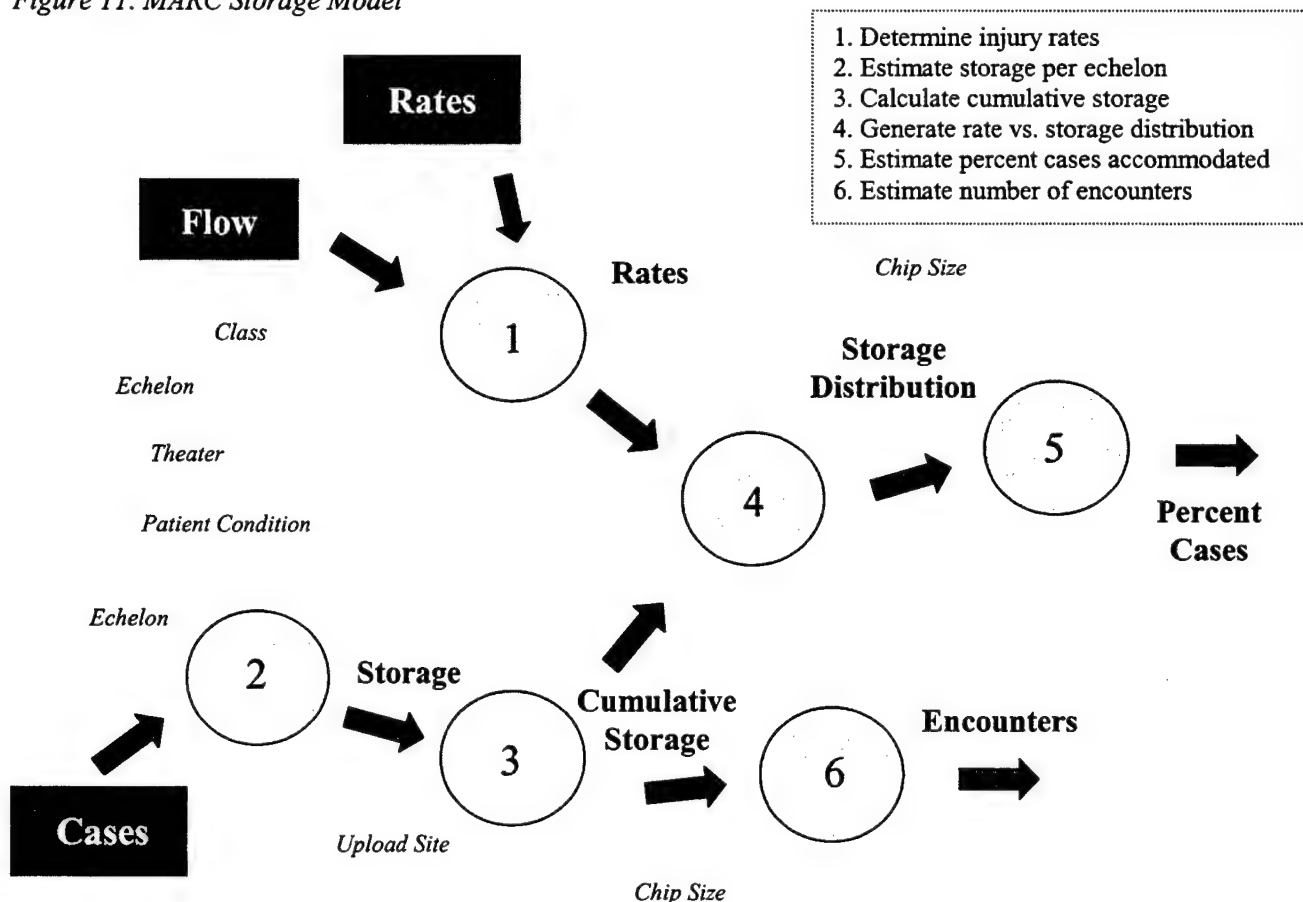
This study indicated that with the implementation of this software into Echelon II, patient medical information could be gathered and patient tracking could be accomplished more quickly and accurately than with the manual method. As with CCC/MIS, MEDTAB and MEDTRAK's inclusion into Echelon II would substantially reduce the number of trained medical providers necessary for administrative duties.¹¹

Multi-technology Automated Reader Card (MARC) Enhanced System (ES)

The most recent automation development for medical information documentation is the MARC Enhanced System (ES) program. Due to the identification of the MARC as a potential storage device for personal medical data, the MARC ES software is designed to estimate storage requirements of the smart card. The storage capacity of the integrated circuit chip on MARC is limited, thereby making it important to discover the memory allocation necessary to document the full range of medical problems, treatments, and patient conditions that could be encountered on the battlefield. Although the MARC ES program is currently specific to the MARC/MEDTAG coding scheme, the user can reconfigure the data element sizes and approximate the storage requirements of any storage technology.

The MARC ES model (Figure 11) is a software program that allows the user to calculate the storage requirements for various scenarios by inputting a series of parameters.¹² Theater, echelon, upload site, chip size, class, and patient condition can be manipulated by the user. These parameters are used in conjunction with historical information contained in data files (injury rates, patient flow, and patient cases) to perform various tasks. After selecting from a list of tasks, the software provides the user with a result table for that task. The list of tasks include storage by echelon, cumulative storage, storage distribution, encounters, and percent cases.

Figure 11. MARC Storage Model



Because MARC ES allows the input of any combination of variables, it enables the user to estimate the total amount of space required to store medical data at each echelon of care for selected operational theaters. MARC ES is also flexible; new updated information can be added at any time to reflect the most current information and advances.¹²

Conclusion

Although NHRC has developed successful prototypes of automation for the First and Second Echelons of care, they have yet to be fielded. The question of how the personal electronic data carrier should be used precludes the realization of the significant and far-reaching improvements demonstrated by NHRC. The personal electronic data carrier can take various forms, MARC being only one possible construct. Because the electronic devices, such as MEDTAG and MEDTAB, must employ a specific technology, the systems cannot be configured and put into operation until a decision is made regarding what strategy will be used to compile individual medical records.

The central issue concerning the implementation of the personal electronic data carrier is whether the card should be used as an individual medical record or as a way to capture information in the field and transport it to the medical record. Is it better to field a comprehensive card dedicated to medical record-keeping in addition to a card for administrative data? Or should a single card be issued that includes medical as one of several components? Essentially, should the personal electronic data carrier be an "unabridged" card containing an individual's entire medical history or an "abridged" card that stores only the essential clinical data set (ie, blood type, allergies) necessary for a provider to successfully treat the individual if an injury occurs?

The capacity of current technology is flexible, ranging from 2K bytes to several megabytes. The unabridged card is filled to capacity to retain an individual's entire medical record including images, whereas the abridged card uses only those data elements needed to store basic identification, demographic, and medical information. While the unabridged card provides complete medical information that can be accessed at any level of care, the abridged card has the ability to perform additional functions with its remaining memory. Therefore, the abridged card can be used during deployment to create manifest records that log military personnel boarding and disembarking from aircraft or ships, to produce accountability reports that track personnel location and status, and to report food service head count data and present the individual with the opportunity to exercise payroll deduction. Furthermore, the abridged card's multipurpose approach allows medical to join with other functional areas to share the cost of producing the card.

There are benefits to both the unabridged and abridged cards. Once the decision between the personal electronic data carriers is made, the implementation of NHRC's prototypes can raise the standard of care, substantially reducing administrative burden and increasing the availability of medical personnel for patient treatment.

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Appendix A

*Listing of MEDTAG
Extended Data Input Menus and Data Items*

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

MAIN MENU

→ ASSESS TREAT COND
 DISP REASSESS HELP
 YES=ENTER; NO=CHANGE
 >ASSESSMENT 12:00

INJURY TYPE MENU (ASSESS)

PROBLEM TYPE:
 → WOUND HEAT/COLD NBC
 DISEASE MORE EXIT
 >WOUND 12:00

MUSCLE/SKELETAL MENU

MUSCLE/SKEL INJURY:
 → FRACT DISLOC AMP
 AVULSION MORE EXIT
 >FRACTURE 12:00

WOUND MENU

WOUND TYPE:
 → TISSUE MUSCLE/SKEL
 INTERNAL MORE EXIT
 >TISSUE 12:00

FRACTURE MENU (FRACT)

OPEN FRACTURE?
 PRESS 'YES' OR 'NO'

TISSUE WOUND MENU

TISSUE WOUND:
 → LACERATE GSW FRAG
 EVISCER MORE EXIT
 >LACERATION 12:00

OTHER MUSCLE/SKELETAL MENU

OTHER MUSCLE/SKELET:
 → SPRAIN STRAIN PULL
 OTHER EXIT
 >SPRAIN 12:00

GUNSHOT EXIT MENU (GSW)

EXIT WOUND?
 PRESS 'YES' OR 'NO'

INTERNAL WOUND MENU

INTERNAL INJURY:
 → CONCUS BLUNT CONTUS
 BLAST OTHER EXIT
 >CONCUSSION 12:00

OTHER TISSUE WOUND MENU (MORE)

OTHER TISSUE WOUNDS:
 → STAB PUNCTURE BITE
 ABRASION OTHER EXIT
 >STAB 12:00

OTHER WOUND MENU

OTHER WOUND TYPES:
 → SUPERFICIAL OTHER
 FOREIGN-OBJ EXIT
 >SUPERFICIAL 12:00

PUNCTURE EXIT MENU

EXIT WOUND?
 PRESS 'YES' OR 'NO'

HEAT/COLD PROBLEM MENU

HEAT/COLD PROBLEM:
 → HEAT COLD
 BURN MORE EXIT
 >HEAT PROBLEM 12:00

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

HEAT PROBLEM MENU

HEAT PROBLEM:
 → STROKE EXHAUSTION
 DEHYD OTHER EXIT
 >HEAT STROKE 12:00

NBC/CBR AGENT MENU

NBC/CBR AGENT:
 → CHEMICAL RADIOLOGIC
 BIOLOGICAL EXIT
 >CHEMICAL 12:00

COLD PROBLEM MENU

COLD PROBLEM:
 → FROSTBITE OTHER
 HYPOTHERMIA EXIT
 >FROSTBITE 12:00

DISEASE MENU

DISEASE:
 → RESP GASTRO SKIN
 STD OTHER EXIT
 >RESPIRATORY 12:00

BURN TYPE MENU

BURN TYPE:
 → THERMAL CHEMICAL
 OTHER EXIT
 >THERMAL BURN 12:00

OTHER INJURY MENU

OTHER INJURY TYPE:
 → POISON STROK STRESS
 INFECT OTHER EXIT
 >POISON 12:00

THERMAL BURN MENU

BURN DEGREE?
 → 1ST 2ND 3RD
 UNKNOWN EXIT
 >1ST DEGREE 12:00

INJURY LOCATION MENU

PROBLEM LOCATION:
 → GEN HEAD UPBODY MID
 PELVIS EXTREMITIES
 >GENERAL 12:00

CHEMICAL BURN MENU

BURN DEGREE?
 → 1ST 2ND 3RD
 UNKNOWN EXIT
 >1ST DEGREE 12:00

GENERAL LOCATION MENU

GENERAL LOCATION:
 → INTERNAL OVERALL
 MENTAL NONSPEC EXIT
 >INTERNAL 12:00

OTHER BURN MENU

BURN DEGREE?
 → 1ST 2ND 3RD
 UNKNOWN EXIT
 >1ST DEGREE 12:00

HEAD LOCATION MENU

HEAD LOCATION:
 → BASE TOP 4HEAD
 SIDE FACE EXIT
 >BASE OF SKULL 12:00

OTHER HEAT/COLD MENU

OTHER HEAT/COLD PROB:
 → SMOK-INHAL OTHER
 IMMERSION-FOOT EXIT
 >INHALATION 12:00

SIDE OF HEAD LOCATION MENU

HEAD SIDE LOCATION:
 → JAW EAR TEMPLE
 EXIT
 >JAW 12:00

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

WHICH SIDE MENU

WHICH SIDE?		
→ LEFT	RIGHT	
BOTH	EXIT	
>LEFT	12:00	

ARM LOCATION MENU

ARM LOCATION:		
→ UPPER	ELBOW	4ARM
WRIST	HAND	FING
EXIT		
>UPPER	12:00	

FACE LOCATION MENU

FACE LOCATION:		
→ EYE	NOSE	MOUTH
CHIN	FACE	EXIT
>EYE	12:00	

LEG LOCATION MENU

LEG LOCATION:		
→ UPPER	KNEE	SHINCALF
ANKLE	FOOT	TOE
EXIT		
>UPPER LEG	12:00	

UPPER BODY LOCATION MENU

UPPER BODY LOCATION:		
→ NECK	SHOULDER	
CHEST	EXIT	
>NECK	12:00	

TREATMENTS MENU

TREATMENTS:		
→ DRESS	APPS	AIRWAY
MEDS	MORE	EXIT
>DRESSINGS	12:00	

CHEST WOUND MENU

SUCKING CHEST WOUND?

PRESS 'YES' OR 'NO'

DRESSINGS MENU

DRESSINGS:		
→ BATTLE	WET	PRESSURE
OCCLUS	MORE	EXIT
>BATTLE	12:00	

MIDSECTION LOCATION MENU

MIDSECTION LOCATION:		
→ SPINE	ABDOMEN	
SIDE	BACK	EXIT
>SPINE	12:00	

OTHER DRESSINGS MENU

OTHER DRESSINGS:		
→ MUSLIN	RGAUZE	GEL
VGAUZE	OTHER	EXIT
>MUSLIN	12:00	

PELVIS LOCATION MENU

PELVIS LOCATION:		
→ HIP	BUTTOCKS	
GENITALS	EXIT	
>HIP	12:00	

APPLICATIONS MENU

APPLICATIONS:		
→ TOURN	SPLINT	SLING
SWATHE	MORE	EXIT
>TOURNIQUET	12:00	

EXTREMITIES LOCATION MENU

EXTREMITIES LOC.:		
→ ARM	LEG	EXIT
>AR M	12:00	

OTHER APPLICATIONS MENU

OTHER APPLICATIONS:		
→ DECON-WIPE	TUBE	
IMMOBILIZE	EXIT	
>DECONTAMINATE	12:00	

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

IMMOBILIZATION MENU

IMMOBILIZATION OF:
 → PATIENT
 OBJECT EXIT
 >PATIENT 12:00

IV MENU

IV's:
 → RINGERS SALINE
 D5W BLOOD EXIT
 >R. LACTATE 12:00

AIRWAY MENU

AIRWAY TREATMENTS:
 → VENT INTUBATE TRACH
 CRICO OTHER EXIT
 >ASSISTED VENT 12:00

MORPHINE MENU

MORPHINE (mg):
 PAST 24 hr. TOTAL: 0
 → 8 16 24 32 EXIT
 >8 mg 12:00

INTUBATE MENU

INTUBATION TYPE:
 → ET-TUBE NG-TUBE
 EXIT
 >ET TUBE 12:00

OTHER TREATMENTS MENU

OTHER TREATMENTS:
 → AFFECTED-SIDE CPR
 SHOCK OTHER EXIT
 >PLACED ON SIDE 12:00

MEDICATIONS MENU

MEDICATIONS:
 → ATROP 2PAM VALIUM
 IV MORPH OTHER EXIT
 >ATROPINE 12:00

CONDITION MENU

PATIENT CONDITION:
 → SHOCK CONSCIOUSNESS
 PULSE RESP EXIT
 >SHOCK 12:00

ATROPINE MENU

ATROPINE INJECTORS:
 PAST 24hr. TOTAL: 0
 → 1 2 3 4 5 EXIT
 >1 INJECTOR 12:00

CONSCIOUSNESS MENU

CONSCIOUSNESS LEVEL:
 → ALERT VERBAL PAIN
 UNRESPONSIVE EXIT
 >ALERT 12:00

2PAM MENU

2PAMCHLOR INJECTORS:
 PAST 24 hr. TOTAL: 0
 → 1 2 3 4 5 EXIT
 >1 INJECTOR 12:00

PULSE MENU

PULSE:
 → NONE 1-59 60-99
 100+ EXIT
 >NONE 12:00

VALIUM MENU

VALIUM (mg):
 PAST 24 hr. TOTAL: 0
 → 5 10 EXIT
 >5 mg 12:00

RESPIRATION MENU

RESPIRATION PER MIN:
 → NONE 1-5 6-9
 10-29 30+ EXIT
 >NONE 12:00

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

DISPOSITION MENU

DISPOSITION:
 → ACTION TAKEN
 PROVIDER EXIT
 >ACTION TAKEN 12:00

BLOOD LOSS MENU

BLOOD LOSS:
 → NONE UNKNOWN SEVERE
 MODERATE MILD EXIT
 >NONE 12:00

DISPOSITION TAKEN MENU

ACTION TAKEN:
 → EVACUATED RETURNED
 EXPIRED EXIT
 >EVACUATED 12:00

GLASGOW MENU

GLASGOW COMA SCALE:
 → EYE VERBAL MOTOR
 EXIT
 > EYE OPENING 12:00

EVACUATION MENU

EVACUATION TYPE:
 → MEDEVAC AMBULATORY
 EXIT
 >MEDEVAC 12:00

EYE OPENING MENU

EYE OPENING LEVEL:
 → SPONTANEOUS VOICE
 PAIN NONE EXIT
 >SPONTANEOUS 12:00

PROVIDER MENU

MEDICAL PROVIDER:
 → CORPSMAN BUDDY SELF
 DOCTOR OTHER EXIT
 >CORPSMAN/MEDIC 12:00

VERBAL MENU

VERBAL LEVEL:
 → ORIENT CONFUS INAPP
 INCOMP EXIT
 >ORIENTED 12:00

REASSESSMENT MENU

REASSESSMENT:
 → VITALS RELIGION
 ORDERS SHOCK EXIT
 >VITAL SIGNS 12:00

MOTOR MENU

MOTOR LEVEL:
 → OBEYS-COMMAND LOCAL
 PAIN-RESPONSE EXIT
 >OBEYS-COMMAND 12:00

VITALS MENU

VITALS:
 → BP BLOOD LOSS PULSE
 GLASGOW RESP EXIT
 >SYSTOLIC BP 12:00

PAIN RESPONSE MENU

RESPONSE TO PAIN:
 → WITHDRAWS FLEXION
 EXTENSION EXIT
 >WITHDRAWS 12:00

BLOOD PRESSURE MENU

SYS. BLOOD PRESSURE:
 → 90+ 76-89 50-75
 1-49 NONE EXIT
 >90+ 12:00

RELIGIOUS SERVICES MENU

RELIGIOUS SERVICES:
 → BAPT ANOINT CONFESS
 PRAY COMMUNION EXIT
 >BAPTISM 12:00

Appendix A. Listing of MEDTAG Extended Data Input Menus and Data Items

ORDERS MENU

ORDERS:
→ ANTIBIOTICS TETANUS
 MEDS OTHER EXIT
>ANTIBIOTICS 12:00

HELP/SHOW DATA MENU

HELP/SHOW-DATA:
→ SHOW-DATA SHOW-ID
 HELP/HOW-TO EXIT
>SHOW-DATA 12:00

MEDICATIONS MENU

MEDICATIONS:
→ ATROP 2PAM VALIUM
 IV MORPH OTHER EXIT
>ATROPINE 12:00

HELP MENU

HELP ON HOW TO:
→ ENTER-DATA
 STOP-CHOKING EXIT
>ENTER DATA 12:00

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14. ABSTRACT It is imperative that medical treatment information be gathered quickly and accurately to ensure continuity of care at far-forward echelons. Each echelon employs a manual method of recording medical information. The methods in use prior to and during the Vietnam War revealed the need for considerable improvements in medical information documentation, patient registration, patient tracking, and effective transference of data throughout each of the first three echelons of care. The US military targeted these inadequacies for development; automation was determined as the direction in which documentation techniques could most significantly be enhanced. The Naval Health Research Center (NHRC) has been an integral part of the development of automation for the far-forward echelons of care. The prototypes designed by NHRC for Echelons I and II can successfully raise the standard of treatment while simultaneously reducing the number of individuals needed for administrative duties, and increasing the number of medical staff available for patient care. An overview of NHRC's work in automation from 1983 to 1997 is presented.					
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